

MRI NOISE AND VIBRATION EFFECTS ON BUILDING DESIGN

By Brad Pridham, Ph.D., Steve Meszaros, M.Sc., P.Eng., Darron Chin-Quee, M.B.A., P.Eng.

INTRODUCTION

Magnetic Resonance Imaging (MRI) scanners create high levels of airborne and structure-borne noise, yet require low vibration environments for good imaging. Too often scanners are sited close to vibration sources and noise sensitive spaces, compromising facility performance.

An awareness of the impacts and requirements of MRI scanners can prevent costly re-designs or post-construction mitigation. A properly designed MRI suite will allow the full imaging potential of the equipment to be realized.

SCANNER SENSITIVITY TO VIBRATION

MRI scanners are sensitive to external vibration well below the threshold of human perception. Scanner exposure to high levels of low frequency vibration can result in **reduced image quality** and **possible missed diagnosis**.

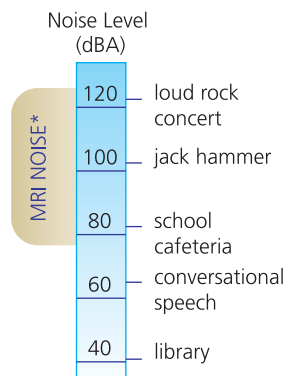
SCANNER-GENERATED NOISE

Noise transmission through building partitions and the structural system results in reduced acoustical comfort in surrounding sensitive spaces. Structure-borne (vibration-induced) noise can impact spaces that are located far from the MRI Room. RWDI has observed these impacts in existing spaces located well away from the scanner. In one case, transmission was limited only by a structural isolation break at 65' from the scanner.

FACTORS AFFECTING CONTROL

Magnet size / field strength, scanning sequence and end use all affect the required level of noise and vibration control. Depending on these factors, scanner sound pressure levels can vary from 80 - 120 dBA (see inset above).

The **scanner location** relative to sensitive spaces also determines the required level of control. In general, scanners located above grade require more costly controls than those at slab-on-grade locations.



*MRI noise level varies depending on scan sequence, and can range from 80 – 120 dBA.



Space planning for MRI installations is paramount as highlighted in this remediation project where a scanner was placed next to a conference room (shown) and above an executive patient suite.



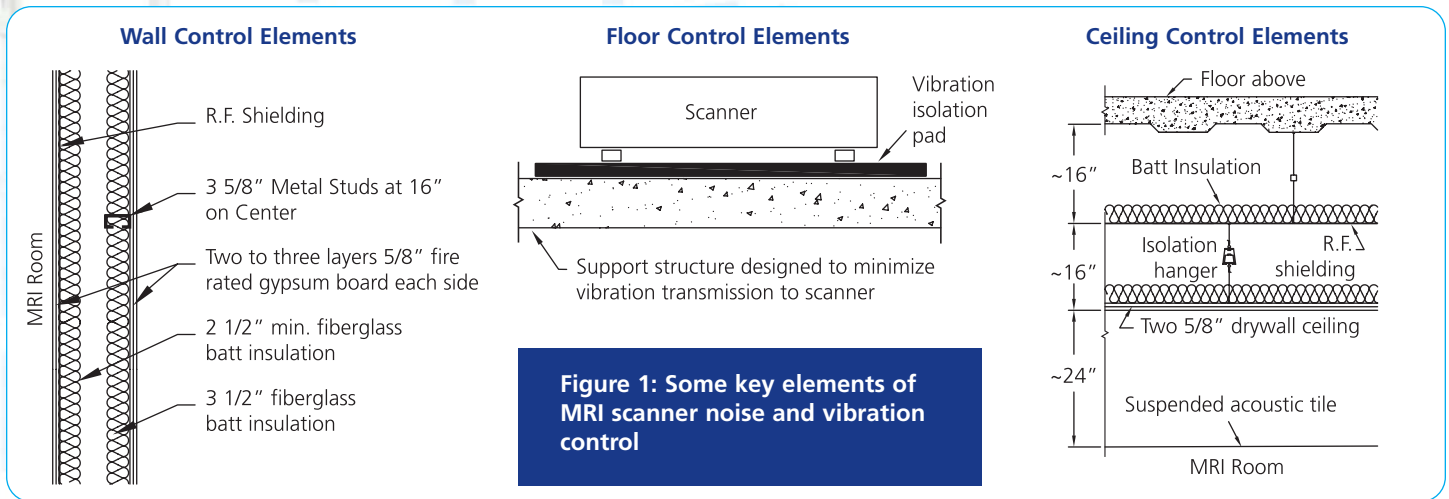


Figure 1: Some key elements of MRI scanner noise and vibration control

CONTROL STRATEGIES

An effective strategy focuses on two elements: containment of airborne noise and structure-borne noise generated by the scanner; and control of external vibration from sources such as footfalls (i.e., walking), roadway and railway traffic. Containment focuses on the control of noise and vibration typically generated by the scanner between 30 Hz and 4000 Hz. Control of external vibration transmitted to the scanner focuses on low frequency vibration (typically less than 100 Hz). Figure 1 highlights some control elements that aim to achieve the following important control strategies.

Airborne noise containment: Upgraded sound isolation (cavity walls, floating floors, resilient ceilings, control room door and window upgrades), space planning and flanking prevention assist in controlling of airborne noise. Locate MRI Rooms away and / or buffered from sensitive spaces to reduce noise transmission. Avoid duct runs that traverse both the MRI Room and adjacent spaces to limit noise flanking. Sound absorptive materials in the MRI Room can reduce airborne noise levels within the MRI Room. Manufacturers offer low-noise scanners that require fewer controls.

Structure-borne noise containment: Reduce noise transmission through the structural system using elastomeric isolation elements and / or construction and isolation joints.

Control of external vibration: The MRI structural support design can be optimized to reduce vibration transmission to the scanner using structural dynamics analysis techniques.

Slab-on-grade installations effectively minimize footfall vibrations, and are ideal for sites where ground-borne

vibration levels (e.g., road and railway traffic) are low. Where ground-borne vibration exists (e.g., subway lines, streetcars and roadways), above grade installation may be preferred.

For installations on floors above grade, footfalls are the primary concern. Controls, such as changes to the structure and / or the installation of secondary flooring, can minimize transmission of footfall vibration to the scanner.

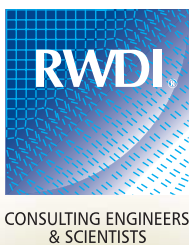
A vibration survey is recommended to ensure MRI and site compatibility. See RWDI Technote 14 for more information.

BALANCING HOLISTIC DESIGN

MRI scanner noise and vibration control strategies need to be well coordinated with multiple aspects of the design. Coordination with structural, architectural, mechanical and R.F. shielding designs is an essential strategy for success.

MRI Noise and Vibration Control Checklist

- Incorporate absorptive finishes in the MRI Exam Room
- Plan space layouts to create buffers
- Allocate space for upgraded acoustical partitions, for example, cavity walls (20 – 24”), floating floor (6 – 10”), resiliently hung gypsum wallboard ceiling (24 – 30”)
- Install vibration isolation elements for controlling structure borne noise
- Ensure proper acoustic and magnetic seals at R.F. shield penetrations
- Upgrade windows and doors in control room
- Assess by measurement and analytical means environmental vibration sources at slab-on-grade locations and/or footfall vibrations at installations above grade



Rowan Williams Davies & Irwin Inc.
(519) 823-1311 www.rwdi.com

RWDI Anemos Ltd.
01582 470250 www.rwdi-anemos.com

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